The Business and Technical Case for Continuous Commissioning® for Enhanced Building Operations

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Abstract: This paper presents both the business and the technical case for the Continuous Commissioning (CC®) [1] of large, institutional buildings for building optimization. Continuous Commissioning® is defined as the ongoing process to resolve operating problems, improve comfort, optimize energy use, and identify retrofits in existing commercial and institutional buildings, and central plant facilities. It is also known as retro-commissioning. A summary of the Energy Systems Laboratory (ESL)[2] experience at Texas A&M University since 1991 will also be presented. The CC process described in this paper has been sucessfully applied in over 80 large and medium-sized buildings by the ESL, with accumulated savings in excess of $70 million [U.S.] since 1991. The practice is growing rapidly in the U.S. and has proven very cost effective.

1. INTRODUCTION

Building heating and cooling equipment and controls are becoming increasingly complex in new and existing buildings. Because of the increased complexity and a constant lack of funding for building maintenance, the vast majority of larger buildings in the United States are not performing as expected. A 1998 study by the U.S. Department of Energy found that more than $40 million [U.S. dollars] in energy savings could be obtained through commissioning only *one percent* of existing buildings over 25,000 ft. square. This lack of optimization is a needless waste of energy and money, derived primarily from fossil fuels. At the same time, occupant productivity is diminished by inadequate or less than optimum heating and cooling and indoor air quality. Hence, the use of Continuous Commissioning techniques to minimize controlable operating expenses and improve occupant comfort is rapidly gaining popularity in the United States since 2000.

1.1 Where It All Began

The CC engineering process was developed by the ESL, starting in 1991. Continuous Comissioning evolved from the comprehensive monitoring and savings verification program for a successful $96 million energy loan program for public buildings known as the Texas LoanSTAR Program where extensive sub-metering clearly identified numerous operational and energy waste issues. Texas A&M has now successfully applied this engineering technique in over 180 large buildings [schools, hospitals, courthouses, office buildings, airport terminals, research laboratories, etc.] with cummative, measured savings in excess of $70 million [U.S.].

1.2 What is Continuous Commissioning?

Continuous Commissioning can be described as an ongoing, whole-building systems approach to

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[1] The term Continuous Commissioning® and CC® are registered U.S. trademarks of the Energy Systems Laboratory, Texas Engineering Experiment Station, Texas A&M University System. To enhance readability, the author will not use these marks for the remainder of this paper.

[2] The Energy Systems Laboratory is a division within the Texas Engineering Experiment Station, one of 8 state agencies in the Texas A&M University System in Texas, U.S.A. Texas A&M University, founded in 1876, has over 42,000 students in College Station, Texas, U.S.A. http://esl.tamu.edu

resolve operational problems, improve comfort, optimize energy use and control strategies and identify retrofits in existing commericial and institutional buildings and central plant facilities. It differs significantly from "new" building commissioning since it focuses on optimizing the building for existing operations, not commissioning to original design conditions, and should be done on a continuing basis. [1][2]."

CC involves a rigorous, whole-building, engineering evaluation of the heating and cooling systems to identify mechanical problems, inadequate operations and maintenance and ineffective control strategies. Some of the most common problems are: 1) Improper calibration of sensors and metering; 2) inadequate control strategies for optimum operation and comfort; 3) incorrect scheduling of heating and cooling equipment; 4) lack of air and water-side economizer equipment; 5) inadequate building automation systems; 6) broken valves, actuators, and dampers; and 7) indequate operations and maintenance practices.

CC is not a preventative building maintenance program which focuses primarily on preventing equipment failures and replacing wear and tear heating and cooling equipment. A building could have adequate operations and maintenance and still need optimization or a "tune-up" performed to reduce energy use and improve comfort. The skill levels required to perform preventative maintenance is significantly lower than that for CC. Also, optimization of building controls is rarely included in a preventative maintenance program. A preliminary CC audit by a skilled specialists can reveal inadequate operations and maintenance items, such as inoperable outside air dampers or broken sensors, and can typically be repaired during the CC process. However, fixing a mechnical air damper is totally different than determing when the damper should be used and what the outside air ratio for an economizer operation should be.

1.3 Who Does CC?

Astute business owners and facility operators who have excessive heating and cooling bills and/or presistent occupant comfort complaints are increasingly turning to this innovative engineering practice. It is very popular with organizations with very high energy use such as hospitals and semi-conductor plants as well as government organizations with longer payback thresehold and huge deferred maintenance.

As previously mentioned, CC should be performed in addition to the typical operations and maintenance activities. It can be performed under different scenarios -- independently on a fee for engineering service basis, where no energy retrofits are involved or as a part of a comprehensive energy retrofit project, involving capital improvements. CC can be done by an engineering firm licnesed by Texas A&M or by highy trained, in-house maintenance staff. CC should be done on a continuing basis since system performance degrades over time and components and sensors fail.

1.4 How Can It Be Paid?

Although the process is considered unique, it can be paid for in the same manner as other low cost energy improvements. It can be paid for separately or bundled as part of an energy improvement package. It can be paid for out of the current operating budget or can be financed as part of of performance contract or a guaranteed savings agreement or through bank financing. Since CC frequently has simple paybacks of less than two years, it can lower a total project payback period significantly when incorporated as part of an energy improvement project. It has a better payback than most lighting retrofits and provides excellent value to an energy improvement project by reducing the overall payback by optimizing the performance of new or modified existing equipment and enhancing occupant comfort.

2. BUSINESS AND TECHNICAL CASE FOR CC

2.1 Business Case

Energy use is one of the largest and easiest to control building operating expense. The owner/operator can positively impact this expense through conservation [turning things off], investing in more efficient lighting and equipment and/or improving the operation and maintenance [O&M]of his building. A fourth option is to otimize energy use and comfort through the CC process which is done outside the O&M process. This fourth option is one of the quickest and least expensive options depending on the age and condition of the facility.

Simple paybacks for CC typically run less than 2 years and cost from $0.25 to 0.50 [U.S. dollars] per square foot of conditioned space. This cost compares very favorably with lighting retrofit that typically have a 5-year payback and require a capital expenditure. Table 1 shows the typical paybacks in a range of facilities and locations.

It is clear from the examples above that investment in CC can provide significant cost and operational benefits to the building owner/operator and is

The judicious use of CC, independently or in conjunction with a comprehensive energy retrofit project, can provide the astute facilty manager with a low-cost alternative to enhance building operations and reduce operating costs.

Some of the business advantages of the CC process include:

1. Yields a high rate of return on investment [paybacks generally less than 24 months] and annual energy savings of 10-25% of whole building energy consumption, compared to other energy saving investments or retrofits.
2. Yields a high rate of return on investment [paybacks generally less than 24 months] and annual energy savings of 10-25% of whole building energy consumption, compared to other energy saving investments or retrofits.
3. Requires minimum or no capital investment which is a frequent deterent to reducing energy use.
4. Improves tennant/occupant comfort and productivity. Comfort levels are defined by ASHRAE technical standards. Productivity is more difficult to quantify but is often detectable.
5. Provides an excellent way to determine baseline energy use in a building. An energy use-baseline is more stable after a building operation is optimized and is usally more accurate due to calibration and submetering. Also, a more accurate baseline helps manage risk to the owner and/or service provider.

2.2 Technical Case

The engineering techniques and processes for optimizing building operations through commissioning have been clearly defined by the Energy Systems Laboratory, the U.S. Department of Energy for its federal building program, several states including California and New York, and a non-profit educational organization know as the Portland Energy Conservation, Inc. Numerous technical documents, handbooks and training have been produced by these organizations to facilitate this engineering practice. Many of the practices are also contained within American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) standards. A delineation of commissioning materials is outside the scope of this paper but may be found on the internet at http://www.peci.org/library.htm.

The technical advantages of the CC process include:

1. Optimum settings for building operations and controls are determined.

2. Deferred maintenance and energy retrofit opportunities are discovered during the diagnostic phase.

3.Cost of expensive retrofits can be avoided through optimizatin versus replacing poor run equipment that provides inadequate conditioning.

4.Provides an engineering solution to HVAC problems in commercial buildings.

Tab.1. Typical Paybacks from CC Performed by ESL

Representative CC Projects by ESL	Building Type	Implementation Costs	CC Annual Savings	Simple Payback/Yrs
Brooke Army Medical Center San Antonio, TX (2002)	Medical Facility	$339,000	$350,000	<1 year
Terrell State Hospital (1998)	Medical Housing	$145,000	$175,000	< 9 months
Alamo Community College District San Antonio, TX (2003 – 2005)	Class rooms, central plants	$616,000 (includes metering & deferred maintenance)	$305,000	<2.3 years
Texas A&M University Campus & Central Plants (2005 – Ongoing)	Academic	$750,000/yr.	$3.5 M/year	<1 year
IBM Austin, TX (2005)	Research, Offices	$80,000	$222,298	< ½ year

Source: Project technical reports by the ESL are available on-line at: http://txspace.tamu.edu/handle/1969.1/1657

3. MARKET BARRIERS TO CC IN THE UNITED STATES

Market barriers still exist for CC in the U.S. and must be overcome before it becomes standard practice in new construction and existing buildings operations. Common barriers include:

1. Lack of Awareness -- It is not easy for decision makers to find reliable, objective information on the application and effectiveness of CC, although the ESL and others have published numerous papers and case studies and developed a “Guidebook to Continuous Commissioning®” in 2002 for the U.S. Department of Energy’s Federal Energy Management Program.

2. Perceived Risk -- Perceived risk in the technical performance of CC is high due to the lack of understanding of the process and the low compatibility between parts, systems and automation controls.

3. Immaturity of Market Infrastructure -- Wide spread use of sound engineering practices such as CC face the “chicken and egg” problem caused by inadequate infrastructure of skilled CC engineers and a lack of automated commissioning tools and software.

The good news is that the use of CC is increasing in many quarters such as federal and state government buildings in the U.S. The U.S. Air Force recently conducted a $1.5 million pilot study of CC in 3 major military installations. The U.S. Army decided in 2005 to CC all of their medical facilities in the U.S. The States of California and New York are investing several million dollars [U.S.] in CC research and market transformation activities.

4. SUMMARY/CONCLUSION

Continuous Commissioning of buildings has many positive benefits from both a business and technical basis such as a very high return on investment [2 yr. paybacks at a cost of $0.25 – 0.50/sq. ft. U.S.] and a sound technical approach to reducing persistent operational and energy waste issues. The use of building commissioning /optimization has increased steadily since 2000.

5. ACKNOWLEDGEMENTS

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